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WATER SUPPLY
DEWATERING
RECHARGING
INVESTIGATIONS
REPORTS

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Mr. T. Iezzi, Sanitary Engineer
Rohm & Haas Company
Box 219
Bristol, Pennsylvania 19007

Dear Mr. Iezzi:

The following is a general description of the geologic setting of the Tulpehocken Creek watershed in Lebanon and Berks Counties, Pennsylvania, and comments relative to a ground-water divide or hydraulic barrier that we believe is effective in preventing the eastward continuation of ground-water flow in the Lebanon Valley carbonate rocks at Womelsdorf.

The Tulpehocken Creek drainage basin, with an area of a little over 200 square miles, is underlain by shale, carbonate formations composed of limestone and dolomite, and by crystalline rock composed chiefly of granite gneiss. A very minor amount of quartzite occurs adjacent to the crystalline rock. Shales underlie about 55% of the watershed, carbonate rocks about 40% and the crystalline rocks and quartzite about 5%.

The shale, which underlies the northern portions of the watershed, is generally medium gray to dark gray but weathers to a light brownish gray color. Most of the rock is quite fine-grained but there are minor zones or thin lenses of clayey sandstone, pure quartzose sandstone, and platy clayey limestone.

The shale weathers relatively rapidly. The combination of large area of outcrop and tendency to erode results in the largest contribution of suspended solids and bed load to the creek, as compared to other areas of the watershed.

Topographically, the Martinsburg shale forms a region dominated by low, rounded hills and rather ill-defined ridges that run parallel to the strike. The subdued ridges reflect sandstone-dominated areas.

Lithologically, the shale is made up of sandy shale and micaceous fine-grained sandstone. It contains layers that are siliceous, sericitic or carbonaceous. In counties to the east, the formation contains some slate beds but slate was not observed in the Tulpehocken watershed.

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Mr. T. Iezzi:

The carbonate rocks of the Tulpehocken watershed generally underlie the southern portion of the drainage system. These rocks consist of alternating beds of limestone and dolomite. The beds are aligned in a general east-west direction and are highly folded and faulted.

Typically, the limestone valley is low with slightly rolling topography. The course of Tulpehocken Creek lies in the limestone valley from its headwaters to Womelsdorf where it turns north and flows over the Martinsburg shale formation until it is within a few miles of its mouth. Near its mouth, the creek re-enters the limestone terrane.

In an area south of Womelsdorf, about midway between the headwaters and the mouth of the creek, the limestone zone has been deeply buried by an intrusive mass of crystalline rock that has been faulted and thrust over the carbonate rocks. This mass of highly resistant rock forms South Mountain. The bulge of crystalline rocks extends northward into and over the limestone belt at Womelsdorf and Robesonia in such a way that the limestone nearly disappears, being reduced in width to a mile or so.

The carbonate rocks occupy a lowland because they are subject to solution by surface and ground water. In some areas of outcrop of these rocks, there is no obvious surface drainage, indicating that precipitation finds its way to subsurface channels and moves out of such areas as ground-water flow. The contribution of suspended solids and bed load to the creek is minimal in those portions of the watershed underlain by the carbonate rocks.

The flow of Tulpehocken Creek in its upper reaches is somewhat anomalous in that a large limestone quarry discharges an average of about 5,000 gallons per minute into the creek near its origin west of Myerstown. A quantity of finely-divided limestone is contributed to the creek at this point. Other quarrying activity has taken place or is now occurring at several locations farther downstream. The quarries contain limestone of high purity but some clayey and micaceous material is discharged from these operations.

It should be noted that areas underlain by carbonate rocks develop deep soil profiles in many places. These soils consist of the residual products of the weathered rocks. They are clayey, often siliceous, and may have a considerable content of other insoluble residues. However, these soils are not subject to appreciable erosion because of the relatively flat topography and extensive subsurface drainage.

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As noted previously, Tulpehocken Creek flows eastward along the axis of the limestone valley to Womelsdorf and then turns northward to a course over an area of Martinsburg shale. This realignment has resulted from the topographic barrier between Womelsdorf and Robesonia formed by the north flank of South Mountain. A remnant of the limestone belt remains in the locality but it is quite narrow. The effect of the resistant crystalline rocks that have partially buried the carbonate has been to shunt the stream farther north.

Our principal interest, of course, is to determine whether the large-scale subsurface flow that characterizes the limestone valley west of this constriction can continue eastward within the limestones and dolomites, or whether essentially all of the subsurface flow finds its path blockaded and is forced out to feed Tulpehocken Creek. Detailed surface flow data and ground-water profiles in the locality are not available, but considerable indirect evidence indicates the existence of a ground-water barrier at this place. We have pointed out previously that the southern boundaries of the watershed are underlain by rocks that would prevent ground-water escape to the south.

There is a low but distinct topographic divide in the limestone belt about half-way between Womelsdorf and Robesonia. No stream crosses this divide nor is there any evidence of underground solution such as sinkholes or solution pits. It appears that the crystalline rocks deepen sharply to the south to depths well beyond the range of typical ground-water circulation for the region. Although the crystalline mass of South Mountain overlies sedimentary formations, including carbonate rocks, the depth may be up to 2,500 feet. Characteristically, solution channels in Lebanon Valley are localized in the upper 300 feet.

In summary, the presently available information concerning ground-water conditions in the Womelsdorf area indicates that ground water moving eastward in the limestones and dolomites of Lebanon Valley encounters an hydraulic divide that essentially conforms to the surface drainage divide between Womelsdorf and Robesonia. If this view is correct, contaminated ground water in the belt of carbonate rocks will not continue to flow eastward past Womelsdorf but will escape by feeding Tulpehocken Creek and continue north and eastward as streamflow over the relatively impermeable shale area.

It is to be noted that stream samples of Tulpehocken Creek do not indicate a pronounced buildup of arsenic below Womelsdorf, but at the same time, we do not have indications that the carbonate aquifers carry a high concentration of arsenic just west of

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Womelsdorf. The relationship in this respect is inconclusive. Based largely on indirect evidence, it is our conclusion that there is essentially no continuation of contaminated ground-water flow eastward beyond Womelsdorf. Neither is there any likelihood that such water can escape to the south out of the watershed.

Very truly yours,

LEGGETTE, BRASHEARS & GRAHAM

Jack B. Graham
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